User's Manual

XBee IO

Rev. A

MCI-MA-0085

MCI Electronics

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Attention: Any changes and modifications done to the device will void its warranty unless expressly authorized by MCI.

Código Manual: MCI – MA - 0085

1 INTRODUCTION 5
2 FEATURES 5
2.1 XBee IO 5
2.2 MCI XBeeIO Controller 5
3 USER INTERFACE / DEVICE PARTS 6
4 X-CTU 8
4.1 X-CTU usage 8
4.1.1 Starting to work with XBee IO 9
5 XBEE IO BOARD 9
5.1 Preliminary Configuration 10
5.2 Cable Replacement 10
5.2.1 Module configuration for Cable Replacement 10
5.3 Local and Remote Control 12
5.3.1 Local Control 12
5.3.2 Remote Control 13
5.3.3 Remote and Local Control Configuration 13
6 XBEE IO CONTROLLER USAGE 14
6.1 Read and Write in XBee IO boards 15
6.2 Adding and removing custom remote modules 16
6.2.1 Adding a new remote module 16
6.3 External XML file usage 18
6.3.1 Creation of a new file 18
6.3.2 Pre-existing file loading 19
6.4 Save changes to non-volatile memory 19
6.5 Update Time change 19
7 ELECTRICAL CHARACTERISTICS 20

8 MECHANICHAL CHARACTERISTICS 20
9 PROBLEM SOLVING 21
10 DOCUMENT HISTORY 21
11 APPENDIX: BASIC LOCAL COMMANDS 22

1 INTRODUCTION

The XBee IO module allows controlling lights, valves, etc, and reading the digital state of switches, sensors or any remote dry contact signal without the need of wiring, doing complicated configurations or programming a device.

The XBee IO can communicate wirelessly with other XBee IO modules through its embedded XBee radio, so it can manage a great number of remote devices.

XBee IO also allows doing Cable Replacement simply and effectively, and it's easily configurable using AT commands, when connected to a computer with serial RS232 interface.

The XBee IO Controller software was developed specially for the XBee IO, and allows reading and controlling a great number of XBee IO modules through its intuitive graphics user interface.

There's also a library available in C#, for Microsoft Windows.

2 FEATURES

2.1 XBee IO

- 4 opto-isolated inputs up to 24VDC
- 4 relay outputs (10A/250VAC - 10A/30VDC)
- 9-35 VDC/VAC - 500mA power supply.
- 4 switches for IN/OUT pin selection.
- XBee/XBee Pro socket (Series 1).
- DB9 Serial RS232 connector

2.2 MCI XBeeIO Controller

- Local/Remote relay control.
- Local/Remote input readings.
- User module management system.
- Simple and intuitive graphics user interface (GUI).
- Compatibility with Microsoft Windows XP/Vista/7.

3 USER INTERFACE / DEVICE PARTS

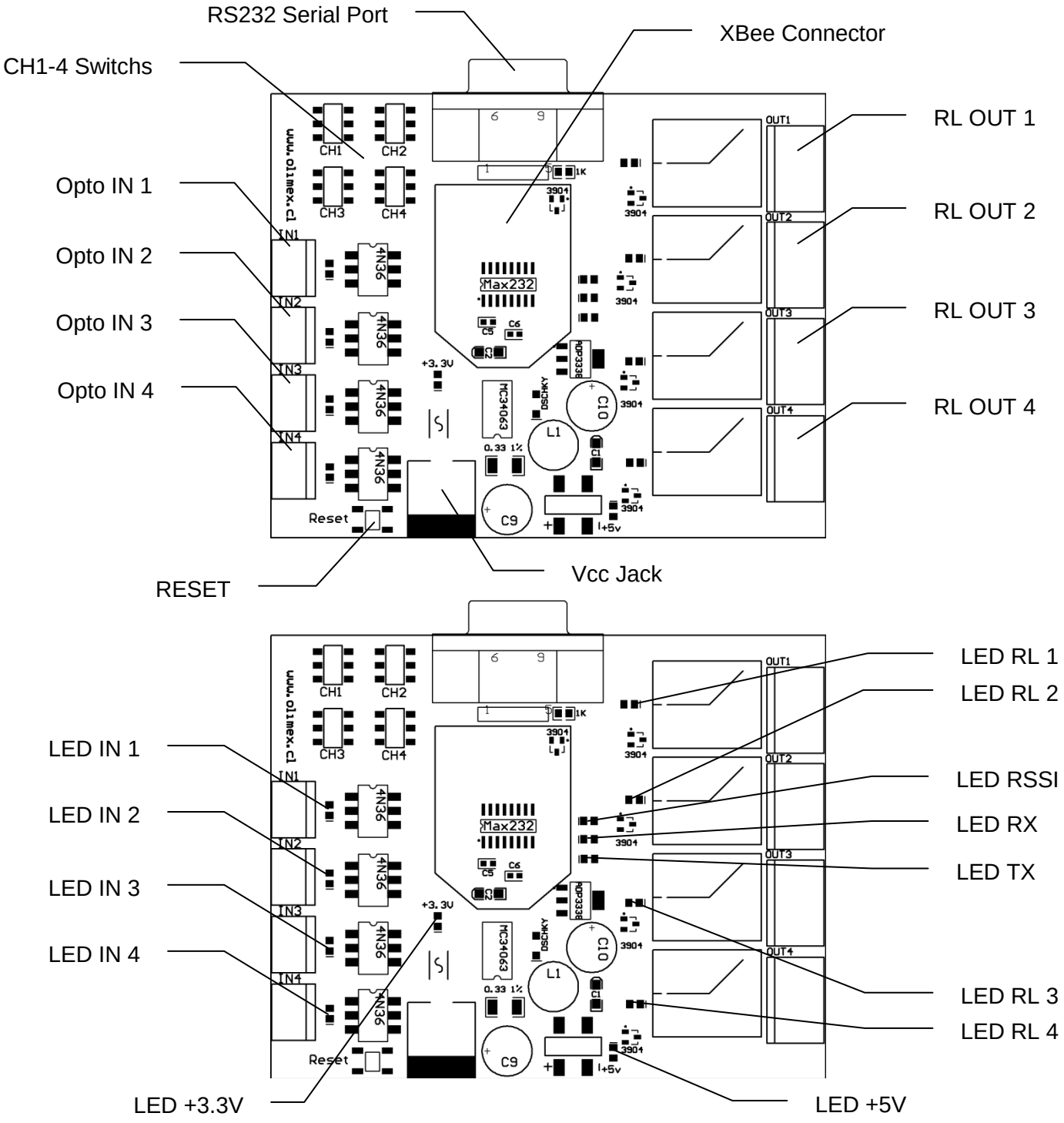

Figure 1: XBee IO board.

- **RS232 Serial Port:** RS232 Communications Serial Port.
- **XBee Connector:** XBee radio connector.
- **RESET:** Board reset button.
- **Vcc Jack:** Vcc power Jack.
- **Opto IN 1-4:** Opto-isolated inputs 1-4.
- **RL OUT 1-4:** Relay Outputs 1-4.
- **LED IN 1-4:** Opto-isolated input state led indicator.
    - **On:** HIGH Input.
    - **Off:** LOW input.
- **LED RL 1-4:** Relay output state led indicator.
    - **On:** Relay on.
    - **Off:** Relay off.
- **LED +5V:** Energized board led indicator.
    - **On:** Energized board.
    - **Off:** De-energized board.
- **LED +3.3V:** Energized board led indicator.
    - **On:** Energized board.
    - **Off:** De-energized board.
- **LED TX:** XBee data transmission led indicator.
    - **Blinking:** Active data transmission.
    - **Off:** Inactive data transmission.
- **LED RX:** XBee Data reception led indicator.
    - **Blinking:** Active data reception.
    - **Off:** Inactive data reception.
- **LED RSSI:** RSSI led. (Rx Signal Strength Indicator)

4 X-CTU

X-CTU is a software developed by Digi International which allows working graphically with XBee, and also includes a console for AT commands. X-CTU allows configuring the XBee registers in a very simple and intuitive way.

X-CTU can be downloaded here.

4.1 X-CTU usage

XBee IO is programmed via its built-in serial connector. A software like X-CTU could be used to do this, or HyperTerminal, through AT commands.

The XBee IO module has three basic functionalities: Cable Replacement, Local Control and Remote Control. These topics will be explained in section 5.

The following image shows the X-CTU main window.

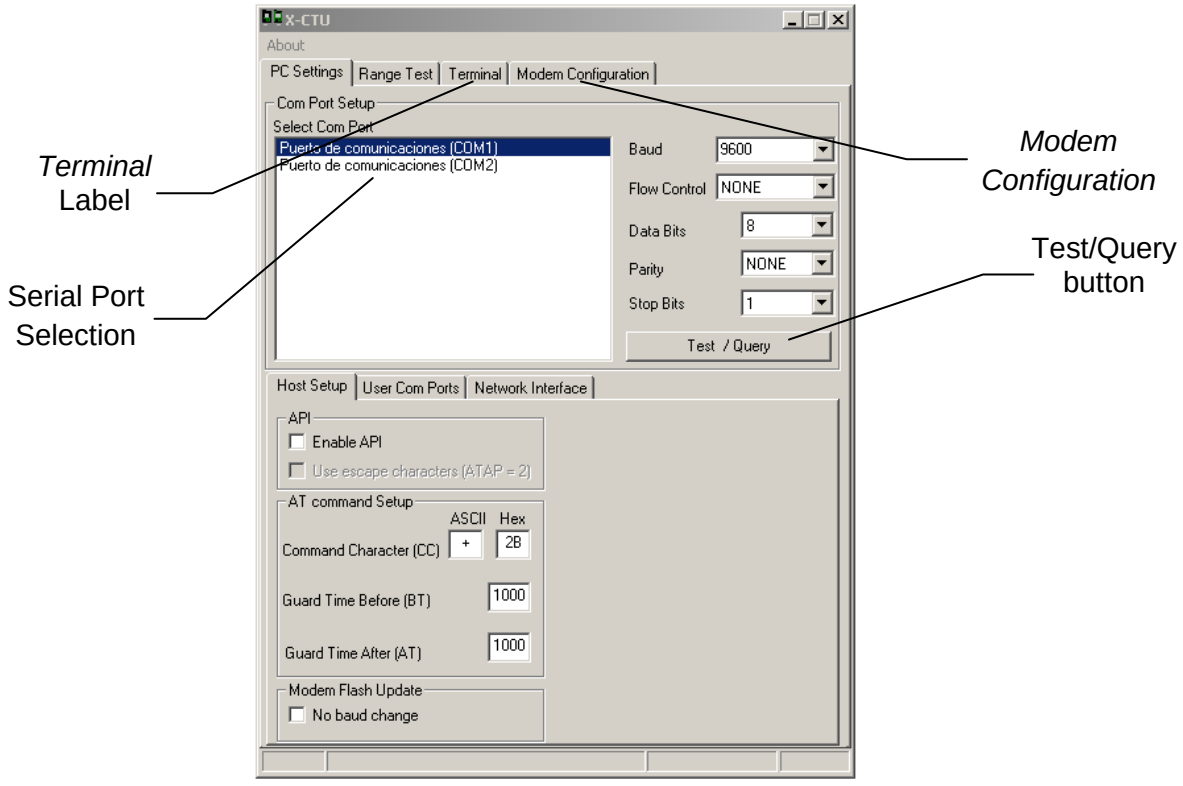

Figure 2: X-CTU main window.

4.1.1 Starting to work with XBee IO

- Select the correct Serial Port.
- Test the module by clicking *Test/Query.*
- Click *Modem Configuration.*
- Click *Read*.
- After changes have been done, click *Write* to save them.

A configuration example is shown herewith:

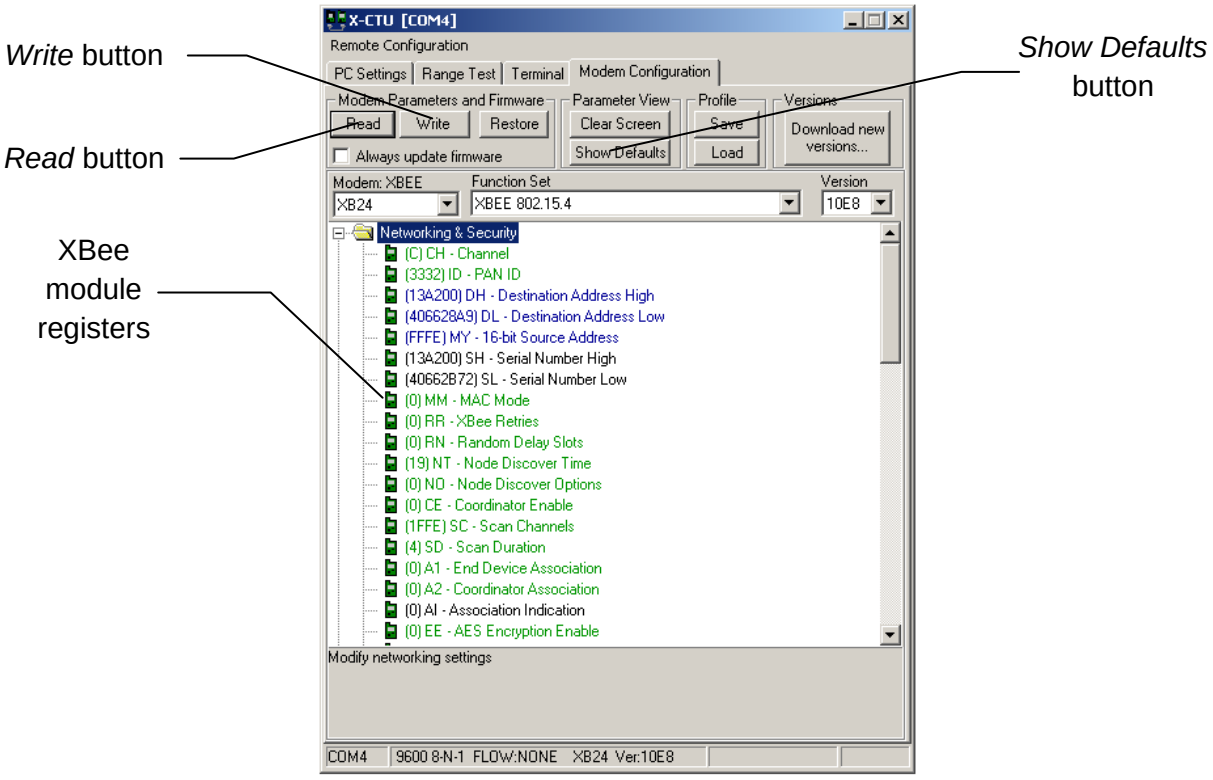

Figure 3: XBee IO configuration.

The XBee registers can be easily modified by clicking them and selecting one of the listed options.

5 XBEE IO BOARD

The XBee IO module was designed to provide 3 basic functionalities to satisfy different needs. The modules can be configured act as Cable Replacement and both local and remote (wireless) modules can be controlled through the serial port.

An XBee Explorer connected to the PC could be used as well.

5.1 Preliminary Configuration

To begin using the module a few steps must be followed:

1. Place the XBee radio on the connector, according to the silkscreen orientation.
2. Connect dry contact inputs
3. Connect relay outputs.
4. Connect the power source (9 - 35 VDC) to the XBee IO module.

5.2 Cable Replacement

Cable Replacement makes a reception board relay output to copy the state of a transmission board input relay pin.

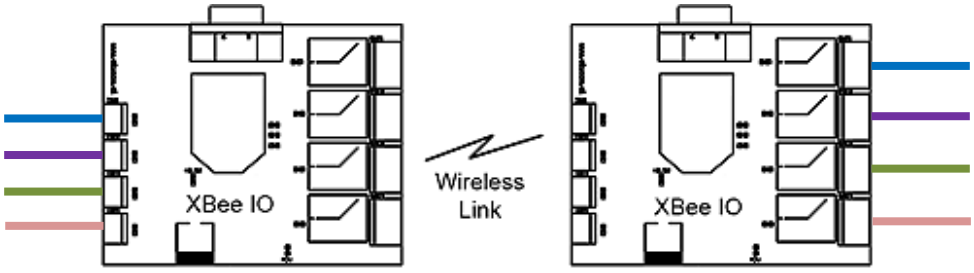

Figure 4: Cable Replacement schematic.

Cable Replacement is especially useful when you have 2 or more modules and you want them to act as if they were connected.

To achieve this functionality a computer connected to the device is not necessary. After the configuration the modules will be working on their own.

It is noteworthy that XBee IO works with digital input signals only.

5.2.1 Module configuration for Cable Replacement

The XBee IO board includes 4 switches to change the module to Writing Mode (Tx) or Reading Mode (Rx).

The switch positions are defined as follows:

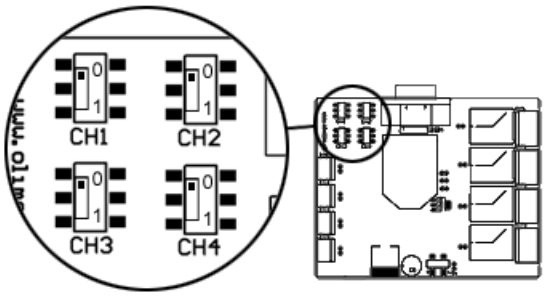

Figure 5: Switch positions.

The black dot in the figure indicates the actual switch position. In this case all the switches are in position 0.

The board works in Reading Mode if all the switchs are in position 0, and in Writing Mode if all are in position 1.

If Cable Replacement functionality is needed, a minimum of 2 modules are required: a reader (Rx) and a writer (Tx).

Before using this functionality, the XBee module has to be configured with X-CTU. (section 4)

The XBee registers has to be configured as follows: (table 1)

The following example is valid for a Reader Module (Tx) with MAC “0013A200 406628A9” and a Writer Module (Rx) with MAC “0013A 200 40662B72”.

Output Module (MAC: 0013A200 406628A9)	Input Module (MAC: 0013A200 40662B72)
ID = 3332	ID = 3332
DH = 13A200	DH = 13A200
DL = 40662B72	DL = 406628A9
D8 = 0	D8 = 0
D7 = 4	D7 = 3
D6 = 4	D6 = 3
D5 = 4	D5 = 3
D4 = 4	D4 = 3
D3 = 4	D3 = 3
D2 = 4	D2 = 3
D1 = 4	D1 = 3
D0 = 4	D0 = 3
IT = 14	IT = 14
IC = FF	IC = FF
IR = FF	IR = FF
IA = FFFF	IA = FFFF
PT = 0	PT = 0
RP = 0	RP = 0

Table 1: XBee register configuration for Cable Replacement.

5.3 Local and Remote Control

The following configurations allow to control modules through the serial port included in the board.

5.3.1 Local Control

This configuration allows the user to control the output relay states and to read the opto-isolated input states of the board connected to the computer.

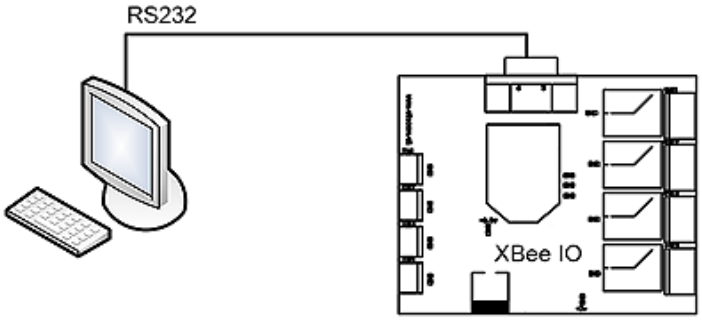

Figure 6: Serial Port local Control schematic.

This configuration is especially useful when you have only one XBee IO, connected to the computer.

Command line AT commands or XBee IO Controller (section 7) can be used to control a local XBee IO.

5.3.2 Remote Control

This configuration is the most powerful, as it allows the user to control a great number of XBee IO remote modules through a local XBee IO module connected to the computer. (or an XBee Explorer)

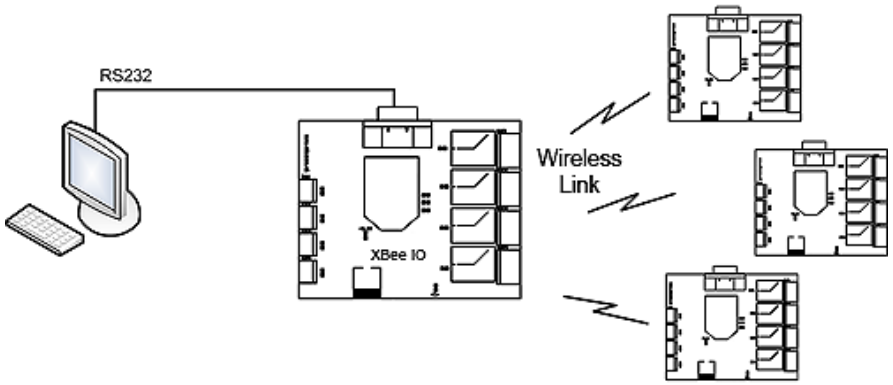

Figure 7: Serial Port Remote Control schematic.

Remote Control is especially useful when you have a great number of XBee IO modules and you want to control them and read their pin states separately, remotely through their wireless link.

5.3.3 Remote and Local Control Configuration

If remote/local control functionalities are required, all the modules switches must be at position 0.

Also, it is necessary to configure the XBee registers with X-CTU (section 4) as follows:

D8 = 0 D7 = 4	D3 = 3 D2 = 3

D6 = 4 D5 = 4 D4 = 4	D1 = 3 D0 = 3 AP = 1

Table 3: XBee register configuration for Local/Remote Control.

It is recommended to first load the Default Configuration, modify the registers and then save the configuration. (*Show Defaults -> Write*)

6 XBEE IO CONTROLLER USAGE

XBee IO Controller is a software which was developed specially by MCI for controlling the XBee IO module. It has a graphics user interface which enables the user to control a great number of XBee IO modules in a very simple and intuitive way.

The program allows to control the relays states and to read the states of the opto-isolated inputs of the selected module. (local or remote)

It also includes a module management system which allows the user to store different module lists, with different user selected names, and load them when required. The files used by the software are XML, so they are simple and portable.

The following figure shows a screen shot of the XBee IO Controller main window:

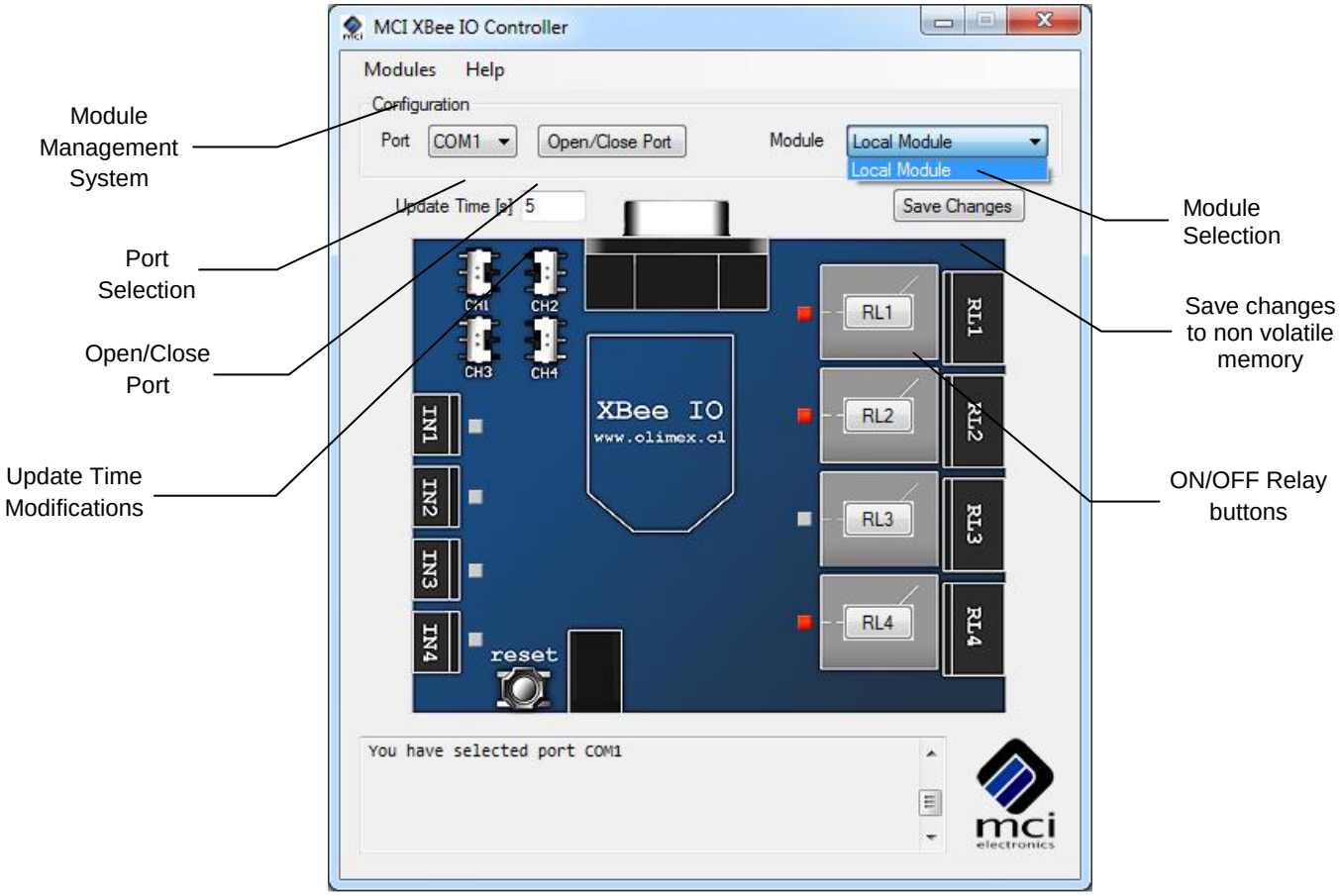

Figure 8: XBee IO Controller main window.

It is important to mention that before using the program, Microsoft .NET Framework 4 must be correctly installed on the computer. You can get it here.

6.1 Read and Write in XBee IO boards

To work with XBee IO Controller a few steps must be followed:

1. Select the desired serial port at the upper left corner of the window.
2. Click *Open/Close Port.*
3. Select the module to use. Only the local module will be listed initially.

The program updates the state of the LEDs in the screen automatically every 5 seconds (default value). This time interval can be changed if required by changing its value in the upper left corner of the window. (*Update Time [s]*)

To turn on and off the relays of the selected module, simply click the corresponding RL1-RL4 button at the right part of the window.

6.2 Adding and removing custom remote modules

To access the module edition menu, click the *Modules* label.

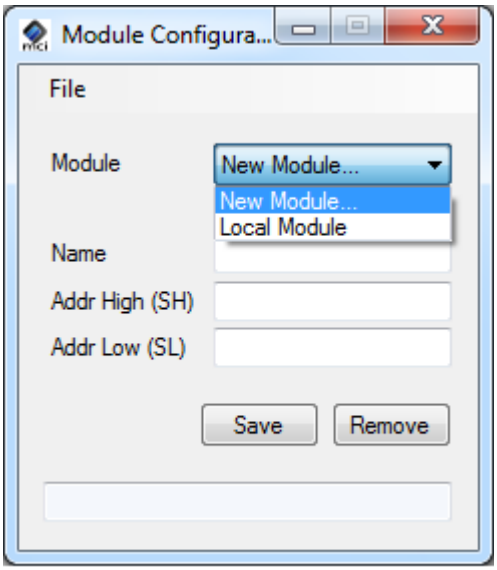

Figure 9: Module Edition window.

The interface has text fields for the alias (name) and the MAC address of the module. This enables the user to fill in the parameters only once and then forget about them. To use the module later the user can simply select it by its alias from the module list menu when required.

Every time a new module is added, the software will automatically save its data on in an external XML file.

The modules can also be edited or even deleted if necessary

6.2.1 Adding a new remote module

- Select *New Module…*
- Enter a name (any) and the Serial Address High (SH) and Serial Address Low (SL) numbers. These numbers can be seen through X-CTU or directly on the back of the XBee radio. (figure 11)
- Click *Save*.

Figure 10: SH and SL on the back of the XBee radio.

The added modules will be stored to the hard drive, and could be used the next time you open the program.

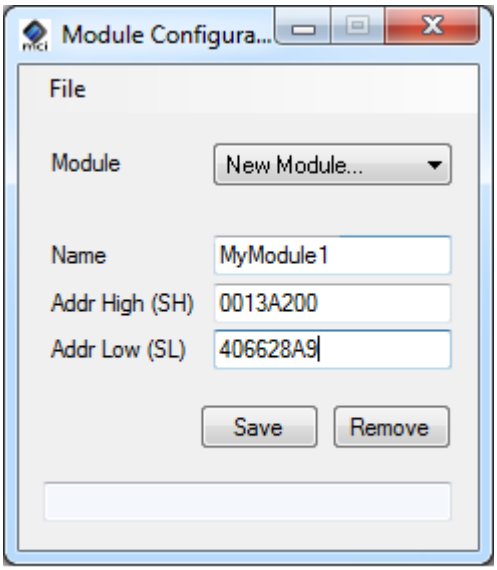

Figure 11: Adding an example module.

To remove a module just select it and then click *Remove*.

6.3 External XML file usage

The program works with XML files to store the custom modules: An alias (custom name) is associated to every MAC direction.

The user can create different module lists, for example for different industrial plants, and load the corresponding file in situ.

Also, the software includes a file management system which enables the user to create new files or load pre-existing files.

It is important to mention that the program uses a default file *Modules.xml*. The program will try to find the file every time the program is executed. If it is not found, the program will create a new one in the folder where the executable file is located.

6.3.1 Creation of a new file

- Click *Modules*.
- Select *New File…*
- Enter a name for the new file and then accept.

After the previous steps a new default file is created.

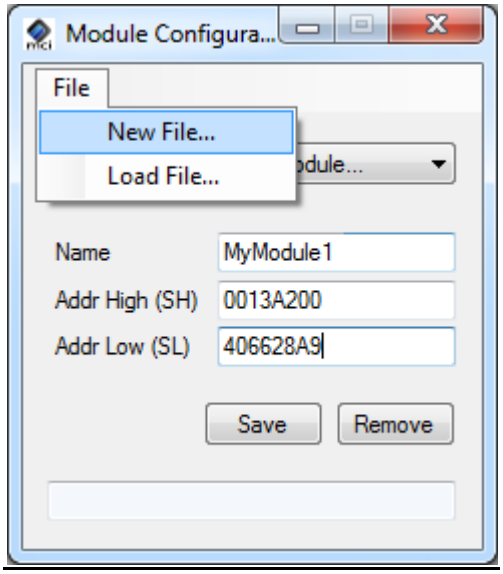

Figure 12: Creation and Load of external XML files.

If you want to use pre-existent files, you will have to load them by clicking *Load File…*

6.3.2 Pre-existing file loading

- Click *Modules*.
- Click *Load File…*
- Select the desired file and then accept.

The program will load to memory all the modules stored in the file, for their use with the graphics user interface.

6.4 Save changes to non-volatile memory

The software includes the capability of writing the relay outputs states to the non-volatile memory of the XBee. This enables the module to “remember” the states of its pins after a reset or power supply failures.

To save changes to the non-volatile memory click *Save Changes.* The program will show an “Ok” message if the command succeeded.

6.5 Update Time change

After a serial port is opened, the program will start to read the states of the opto-isolated input pins of the selected module, constantly. The time interval is given by the Update Time parameter.

The default value of the Update Time parameter is 5 [s], but it can be changed in the textbox at the left corner of the window, whenever required.

Only values between 1 and 999[s] are valid.

7 ELECTRICAL CHARACTERISTICS

Power supply voltage range: 9-35 VDC/VAC

Average power consumption: ~50mA idle. ~250 mA with the 4 relays ON. (@ 9V)

8 MECHANICHAL CHARACTERISTICS

Dimensions 100x80 [mm]

9 PROBLEM SOLVING

Most frequent problems:

- The board stops responding in AT command mode:
  Send a +++ command to reactivate it. The XBee radio goes to low power mode after 10 [s] if no commands are received. (Default time)

- The board does not respond to 802.15.4 frames:
  Check that the API mode is activated with X-CTU (AP=1)

- The board does not turn on/off a relay:
  Check the CH1-CH4 switch positions.

10 DOCUMENT HISTORY

Revision	Date	Edited by	Description/Changes
1.0	March 7, 2011	Carlos Apablaza B	Initial Version of the Document
1.1	September 15, 2011	Eduard Martin	Correction of cable replacement configuration

11 APPENDIX: BASIC LOCAL COMMANDS

To communicate with the XBee IO through AT commands, you must click *Terminal*, in X-CTU. (Section 4)

The following image is a screenshot of the Terminal window of X-CTU.

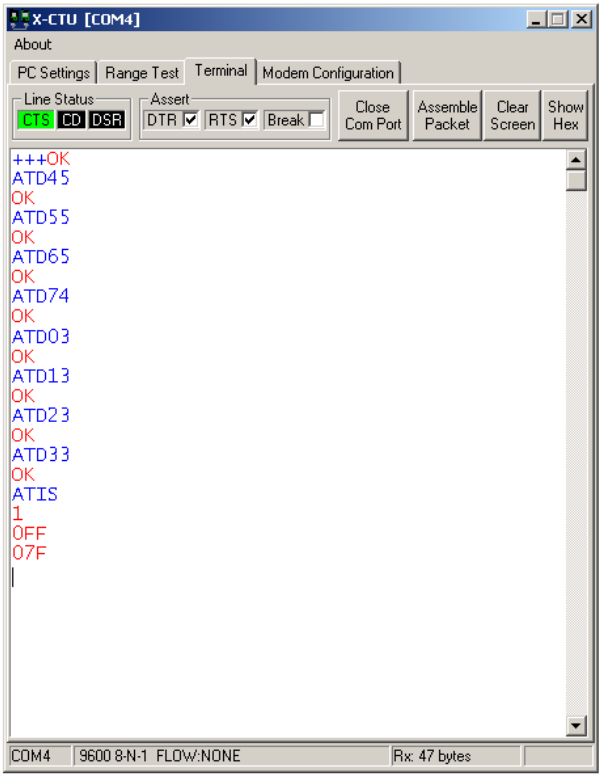

Figure 13: XBee IO – X-CTU Interaction example.

The following is a list of basic AT commands.

- **+++**: XBee module goes to configuration mode.
- **ATDxy :** Sets the digital pin *x* (0 to 8) in mode *y* (0 to 5)

  ATD45 turns on RL 1. ATD44 turns off RL 1.
  ATD55 turns on RL 3. ATD54 turns off RL 3.
  ATD65 turns on RL 4. ATD64 turns off RL 4.
  ATD75 turns on RL 2. ATD74 turns off RL 2.

- **ATIS:** Reads the I/O pin states of the XBee.

ATIS returns 3 registers in hexadecimal codification, with the following format:

Number of samples<CR>
channel mask<CR>
DIO data<CR> (If DIO lines are enabled<CR>
<CR> (end of data noted by extra <CR>)

The returned DIO data value is the state of the pins of the XBee radio.

In the figure 13 example, the DIO data information corresponds to:

Hexadecimal representation

0	7	F

Binary representation

0 0 0 0	0 1 1 1	1 1 1 1

DIO7 DIO0

The second and third block (left to right) corresponds to the DIO7 – DIO0 input/outputs.

In this case DIO7 is HIGH, and DIO0 is LOW.

The first 4 zeros are not relevant.

- **ATAC**: Apply the changes to the XBee radio.

For more information refer to the user manual of the XBee you are using.